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Quarterly Report

No.14

LIFAC Sorbent Injection Desulfurization Demonstration Project

Presented By

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A Joint Venture Between

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Presented To

U.S. Department of Energy

Pittsburgh Energy Technology Center
Pittsburgh, Pennsylvania 15236

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LIFAC SORBENT INJECTION
DESULFURIZATION DEMONSTRATION PROJECT

QUARTERLY REPORT NO. 14
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Submitted to

U. S. DEPARTMENT OF ENERGY

by
LIFAC NORTH AMERICA

INTRODUCTION

In December 1989, the U.S. Department of Energy selected 13 projects for funding under the Federal Clean Coal Technology Program (Round III). One of the projects selected was the project sponsored by LIFAC North America, (LIFAC NA), titled "LIFAC Sorbent Injection Desulfurization Demonstration Project." The host site for this $22 million, three-phase project is Richmond Power and Light's Whitewater Valley Unit No. 2 in Richmond, Indiana. The LIFAC technology uses upper-furnace limestone injection with patented humidification of the flue gas to remove 75-85% of the sulfur dioxide (SO_2) in the flue gas.

In November 1990, after a ten (10) month negotiation period, LIFAC NA and the U.S. DOE entered into a Cooperative Agreement for the design, construction, and demonstration of the LIFAC system. This report is the fourteenth Technical Progress Report covering the period January 1, 1994 through the end of March 1994. Due to the power plant's planned outage in March 1991, and the time needed for engineering, design and procurement of critical equipment, DOE and LIFAC NA agreed to execute the Design Phase of the project in August 1990, with DOE funding contingent upon final signing of the Cooperative Agreement.

BACKGROUND

Project Team

The LIFAC demonstration at Whitewater Valley Unit No. 2 is being conducted by LIFAC North America, a joint venture partnership between:

- <u>ICF Kaiser Engineers</u> - A U.S. company based in Oakland, California, and a subsidiary of ICF Kaiser International, Inc. (ICF) based in Fairfax, Virginia.

- <u>Tampella Power Corp.</u> - A U.S. subsidiary of a large diversified international company, Tampella Corp., based in Tampere, Finland and the original developer of the LIFAC technology.

LIFAC NA is responsible for the overall administration of the project and for providing the 50 percent matching funds. Except for project administration, however, most of the actual work is being performed by the two parent firms under service agreements with LIFAC NA. Both parent firms work closely with Richmond Power and Light and the other project team members, including ICF Resources, the Electric Power Research Institute (EPRI), Indiana Corporation for Science and Technology (ICS&T), and Black Beauty Coal Company. LIFAC NA is having ICF Kaiser Engineers manage the demonstration project out of its Pittsburgh office, which provides excellent access to the DOE representatives of the Pittsburgh Energy Technology Center. Figure 1 shows the management structure being used throughout the three phases of the project.

LIFAC NA administers the project through a Management Committee that decides the overall policies, budgets, and schedules. All funding sources, invoicing, and information flows to LIFAC NA where the managing partners ensure that the project, funding and expenditures are consistent and in-line with the established policies, budgets, schedules and procedures.

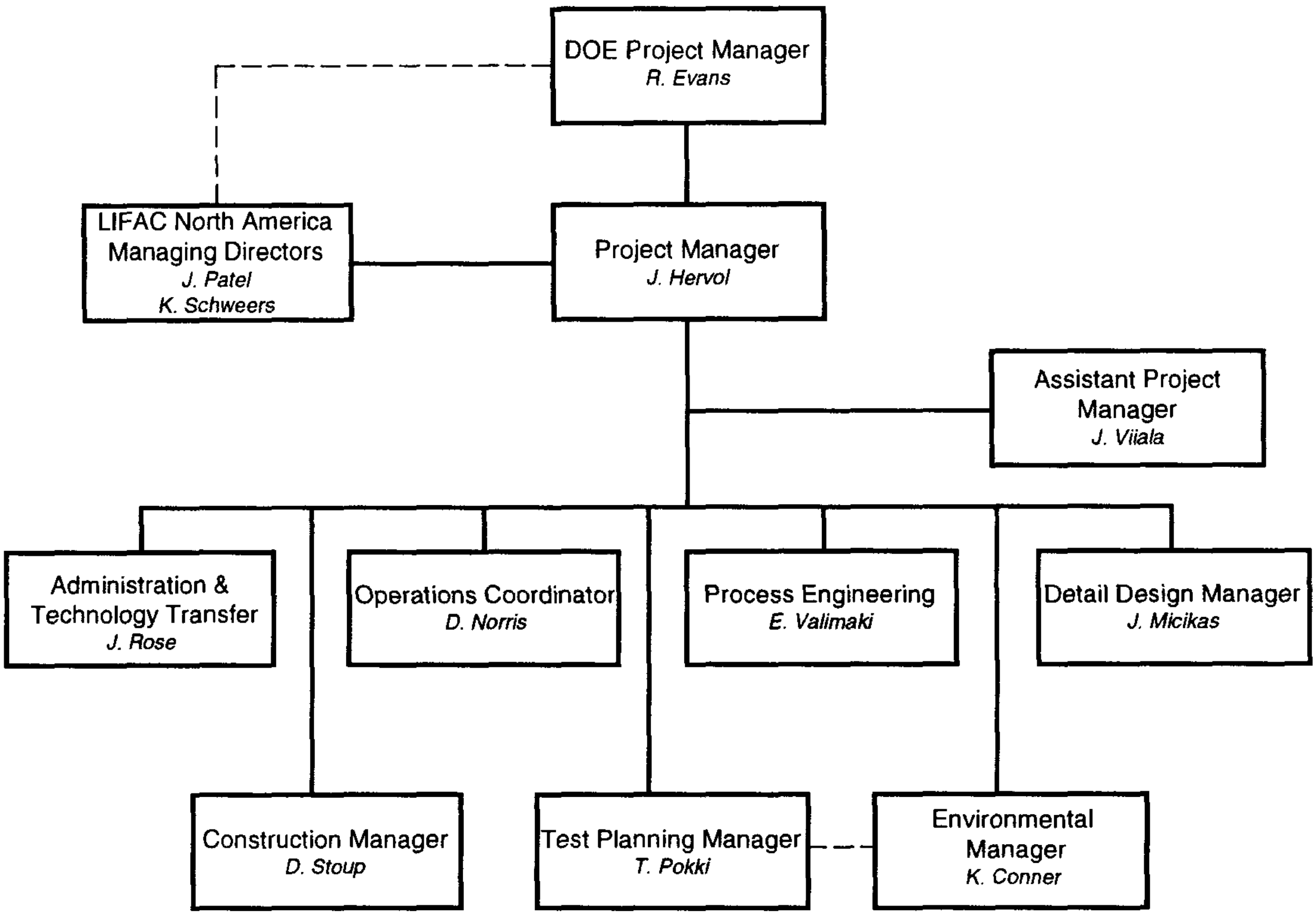
Process Development

In 1983, Finland enacted acid rain legislation which applied limits on SO_2 emissions sufficient to require that flue gas desulfurization systems have the capability to remove about eighty percent (80%) of the sulfur dioxide in the flue gas. This level could be met by conventional scrubbers, but could not be met by then available sorbent injection technology. Therefore, Tampella began developing an alternative system which resulted in the LIFAC process.

Initially, development included laboratory-scale and pilot-plant tests. Full-scale limestone injection tests were conducted at Tampella's Inkeroinen facility, a 160 MW coal-fired boiler using high-ash, low-sulfur Polish coal. At Ca:S ratios of 3:1, sulfur removal was less than 50%. Better results could have been attained using lime, but was rejected because the cost of lime is much higher than that of limestone.

In-house investigations by Tampella led to an alternative approach involving humidification in a separate vertical chamber which became known as the LIFAC Process. In cooperation with Pohjolan Voima Oy, a Finnish utility, Tampella installed a full-scale limestone injection facility on

Project Organization



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a 220 MW coal-fired boiler located at Kristiinankaupunki. At this facility, a slipstream (5000 SCFM) containing the calcined limestone was used to test a small-scale activation reactor (2.5 MW) in which the gas was humidified. Reactor residence times of 3 to 12 seconds resulted in SO_2 removal rates up to 84%. Additional LIFAC pilot-scale tests were conducted at the 8 MW (thermal) level at the Neste Kulloo combustion laboratory to develop the relationships between the important operating and design parameters. Polish low-sulfur coal was burned to achieve 84% SO_2 removal.

In 1986, full-scale testing of LIFAC was conducted at Imatran Voima's Inkoo power plant on a 250 MW utility boiler. An activation chamber was built to treat a flue gas stream representing about 70 MW. Even though the boiler was 250 MW, the 70 MW stream represented about one-half of the flue gas feeding one of the plant's two ESP's (i.e., each ESP receives a 125 MW gas stream). This boiler used a 1.5% sulfur coal and sulfur removal was initially 61%. By late 1987, SO_2 removal rates had improved to 76%. In 1988, a LIFAC activation reactor was added to treat an additional 125 MW -- i.e., an entire flue gas/ESP stream-worth of flue gas from this same boiler. This newer activation reactor is achieving 75-80% SO_2 removal with Ca:S ratios between 2:1 and 2.5:1. In 1988, the first tests using high-sulfur U.S. coals were run at the pilot scale at the Neste Kulloo Research Center, using a Pittsburgh No. 8 coal containing 3% sulfur. SO_2 removal rates of 77% were achieved at a Ca:S ratio of 2:1.

This LIFAC demonstration project is being conducted on a 60 MW boiler burning high-sulfur U.S. coals to demonstrate the commercial application of the LIFAC process to U.S. utilities.

Process Description

LIFAC combines upper-furnace limestone injection followed by post-furnace humidification in an activation reactor located between the air preheater and the ESP. The process produces a dry and stable waste product that is partially removed from the bottom of the activation reactor and partially removed at the ESP.

Finely pulverized limestone is pneumatically conveyed and injected into the upper part of the boiler. Since the temperatures at the point of injection are in the range of 1800-2000° F, the limestone ($CaCO_3$) decomposes to form lime (CaO). As the lime passes through the furnace, initial desulfurization reactions take place. A portion of the SO_2 reacts with the CaO to form calcium sulfite ($CaSO_3$), part of which then oxidizes to form calcium sulfate ($CaSO_4$). Essentially all of the sulfur trioxide (SO_3) reacts with the CaO to form $CaSO_4$.

The flue gas and unreacted lime exit the boiler and pass through the air preheater. On leaving the air preheater, the gas/lime mixture is directed to the patented LIFAC activation reactor. In the reactor, additional sulfur dioxide capture occurs after the flue gas is humidified with a water spray. Humidification converts lime (CaO) to hydrated lime, $Ca(OH)_2$, which enhances further SO_2 removal. The activation reactor is designed to allow time for effective humidification of the flue gas, activation of the lime, and reaction of the SO_2 with the sorbent. All the water droplets evaporate before the flue gas leaves the activation reactor. The activation reactor is also designed specifically to minimize the potential for solids build-up on the walls of the chamber. The net effect is that at a Ca:S ratio in the range of 2:1 to 2.5:1, 70-80% of the SO_2 is removed from the flue gas.

The flue gas leaving the activation reactor then enters the existing ESP where the spent sorbent and fly ash are removed from the flue gas and sent to the disposal facilities. ESP effectiveness is also enhanced by the humidification of the flue gas. The solids collected by the ESP consist of fly ash, $CaCO_3$, $Ca(OH)_2$, CaO, $CaSO_4$, and $CaSO_3$. To improve utilization of the calcium, and increase SO_2 reduction to between 75 and 85%, a portion of the spent sorbent collected in the bottom of the activation reactor and/or in the ESP hoppers is recycled back into the ductwork just ahead of the activation reactor.

Process Advantages

The LIFAC technology has similarities to other sorbent injection technologies using humidification, but employs a unique patented vertical reaction chamber located down-stream of the boiler to facilitate and control the sulfur capture and other chemical reactions. This chamber improves the overall reaction efficiency enough to allow the use of pulverized limestone rather than more expensive reagents such as lime which are often used to increase the efficiency of other sorbent injection processes.

Sorbent injection is a potentially important alternative to conventional wet lime and limestone scrubbing, and this project is another effort to test alternative sorbent injection approaches. In comparison to wet systems, LIFAC, with recirculation of the sorbent, removes less sulfur dioxide - 75-85% relative to 90% or greater for conventional scrubbers - and requires more reagent material. However, if the demonstration is successful, LIFAC will offer these important advantages over wet scrubbing systems:

- LIFAC is relatively easy to retrofit to an existing boiler and requires less area than conventional wet FGD systems.

- LIFAC is less expensive to install than conventional wet FGD processes.

- LIFAC's overall costs measured on a dollar-per-ton SO_2 removed basis are less, an important advantage in a regulatory regime with trading of emission allocations.

- LIFAC produces a dry, readily disposable waste by-product versus a wet product.

- LIFAC is relatively simple to operate.

HOST SITE DESCRIPTION

The site for the LIFAC demonstration is Richmond Power and Light's Whitewater Valley 2 pulverized coal-fired power station (60 MW), located in Richmond, Indiana. Whitewater Valley 2, which began service in 1971, is a Combustion Engineering tangentially-fired boiler which uses high-sulfur bituminous coal from Western Indiana. Actual power generation produced by the unit approaches 65 megawatts. As such, it is one of the smallest existing, tangentially-fired units in the United States. The furnace is 26-feet, 11-inches deep and 24-feet, 8-inches wide. It has a primary and secondary superheater. Tube sizes and spacings are designed to achieve the highest possible heat-transfer rates with the least potential for gas-side fouling. The unit also has an inherent low draft-loss characteristic because of the lack of gas turns. At full load 540,000 lbs/hr. of steam are generated. The heat input at rated capacity is 651 x 10^6 Btu per hour. The design superheater outlet pressure and temperature are 1320 psi at 955°F. The unit has a horizontal shaft basket-type air preheater. The temperature leaving the economizer is about 645°F, while the stack gas temperature is about 316°F. The balanced-draft unit has 12 burners.

In 1980 the unit was fitted and fully optimized with a state-of-the-art Low-NO_x Concentric Firing System (LNCFS). The LNCFS represents a very cost effective means of reducing NO_x emissions in comparison with other retrofit possibilities. The system works on the principal of directing secondary air along the sides of the furnace and creating a fuel rich zone in the center of the furnace. With the LNCFS, the excess air can be maintained below 20 percent. Additionally, the installation reduces ash accumulation on the furnace walls increasing heat absorption and reducing attemperation requirements. With the LNCFS, each corner of the furnace has a tangential windbox consisting of three coal compartments and four auxiliary air compartments. At full load with all three 593 RB pulverizers operating, primary transport air from the pulverizers amounts to 23 percent of the total combustion air. Pulverizer capacity is 26,400 lbs/hr. with 52 grind coal and 70 percent minus 200 mesh.

Whitewater Valley 2 has a Lodge Cottrell cold side precipitator which was erected with the boiler. The precipitator treats 227,000 actual cubic feet per minute of 316°F flue gas with 45,000 square feet of collection area. The unit has two mechanical fields and four electrical fields and achieves 99 percent removal efficiency (from 3.9 gr/ft^3 to 0.04 gr/ft^3). The ESP performance was optimized by Lodge Cottrell when Richmond Power and Light purchased new controllers in 1985.

Whitewater Valley Unit 2's overall efficiency of 87.47 percent at full load has shown little variation over the years. The unit's average heat rate is 10,280 Btu/Kwh. At 60 percent of full load, the unit's efficiency increases to 88.17 percent. The unit uses approximately 0.935 pounds of coal per Kwh and generates 8.51 pounds of steam per Kwh.

The primary emissions monitored at the station are SO_2 and opacity. SO_2 emissions are calculated based on the coal analysis and are limited to 6 lbs/Mbtu. Opacity is monitored using an in-situ meter at the stack and is currently limited to 30 percent. Current SO_2 emissions for the unit are approximately 4 lbs/Mbtu, while opacity at full load ranges from 15 to 20 percent. Opacity at low load (40MW) ranges from 3 to 5 percent. Limited testing was conducted in November of 1986 for NO_x emissions. Results from the test work indicated that NO_x emissions averaged 0.65 lbs/MBtu.

Whitewater Valley 2 has several important qualities as a LIFAC demonstration site. One of these is that Whitewater Valley 2 was the site of a prior joint EPA/EPRI demonstration of LIMB sorbent injection technology. Much of the sorbent injection equipment remains on site and is being used in the LIFAC demonstration. Another advantage of the site is that Whitewater Valley 2 was a challenging candidate for a retrofit due to the cramped conditions at the site. The plant is thus typical of many U.S. power plants which are potential sites for application of LIFAC. In addition, the Whitewater Valley 2 boiler is small relative to its capacity; hence, it has high-temperature profiles relative to other boilers. This situation requires sorbent injection at higher points in the furnace to minimize deadburning of the reagent, but it decreases residence times needed for sulfur removal. Whitewater Valley 2 will show LIFAC's performance under operational conditions most typical of U.S. power plants. The project will demonstrate LIFAC on high-sulfur U.S. coals and is a logical extension of the Finnish demonstration work and important for LIFAC's commercial success in the U.S.

PROJECT SCHEDULE

To demonstrate the technical viability of the LIFAC process to economically reduce sulfur emissions from the Whitewater Valley Unit No. 2, LIFAC NA is conducting a three-phase project.

Phase I: **Design**

Phase IIA: **Long Lead Procurement**

Phase IIB: **Construction**

Phase III: **Operations**

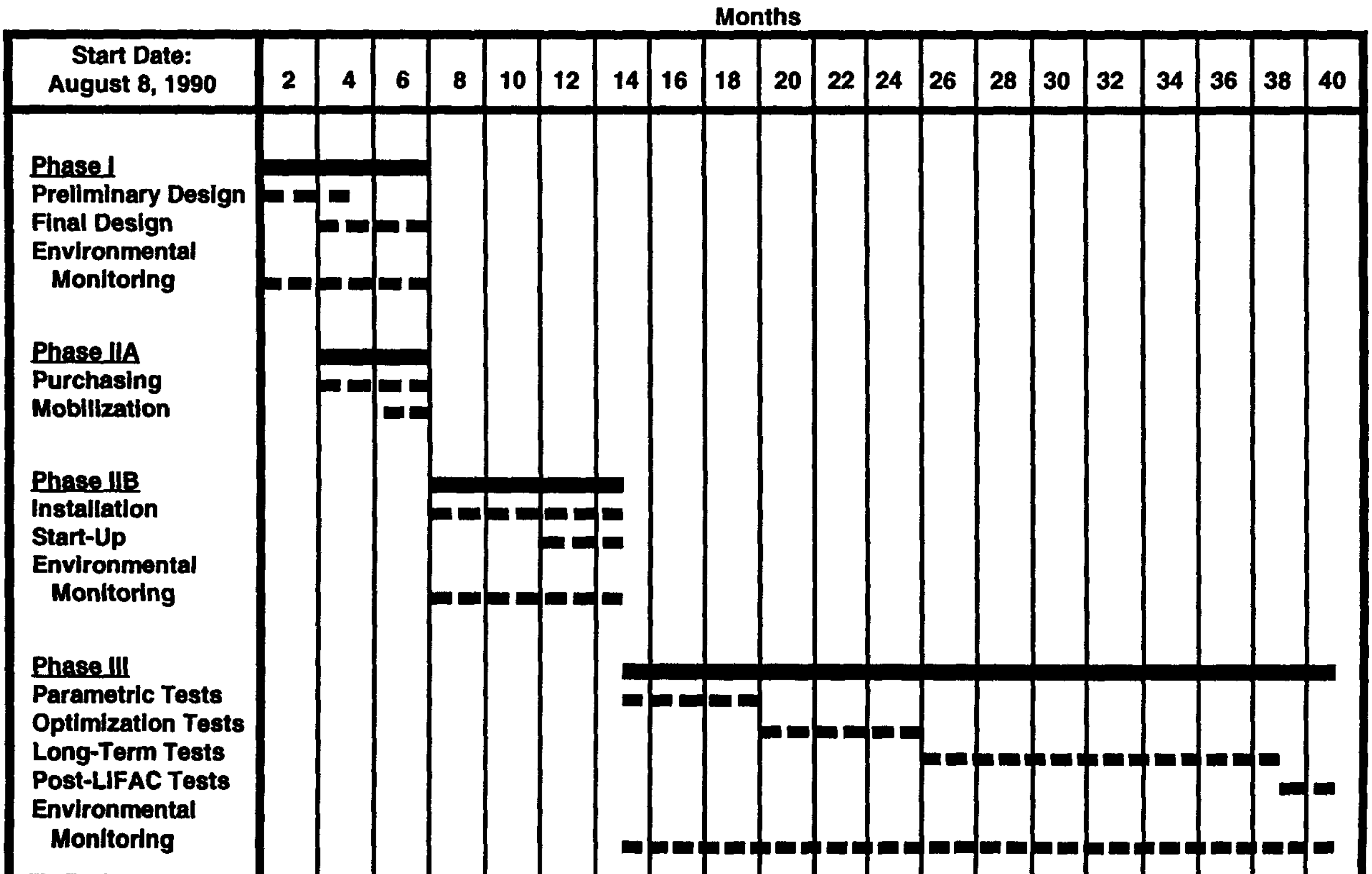
Except Phase IIA, each phase is comprised of three (3) tasks, a management and administration task, a technical task and an environmental task. The design phase began on August 8, 1990 and was scheduled to last six (6) months. Phase IIA, long lead procurement, overlaps the design phase and was expected to require about four (4) months to complete. The construction phase was then to continue for another seven (7) months, while the operations phase was scheduled to last about twenty-six (26) months. Figure 2 shows the original estimated project schedule which is based on an August 8, 1990 start date and a planned outage of Whitewater Valley 2 during March 1991.

It is during this outage that all the tie-ins and modifications to existing Unit No. 2 equipment were made. This required that the construction phase begin in early February, 1991 -- construction was to be completed by the end of August 1991. Operations and testing were to begin in September 1991 and continue for 26 months. However, during previous reporting periods, the project encountered delays in receiving its construction permit. These delays, along with some design changes, and an approved expansion in project scope required that the Design Phase be extended by about eleven months. Therefore, construction was not completed until early June 1992. This represents a nine-month extension in the overall schedule. During the last half of 1992, problems were encountered during startup and commissioning of some of the LIFAC components and systems. These problems required the parametric tests to be delayed until the first quarter 1993 which subsequently required adjustments in the entire testing schedule. During the initial parametric tests conducted during the first quarter of 1993, problems were encountered with increased opacity levels. These problems (see quarterly report No. 10) forced an extension in the parametric test schedule. Due to these delays, an adjustment was made during the second quarter of 1993 (report No. 11) to the testing schedule (see Figure 3). These delays, however, will not impact the overall duration of the Operations Phase and

LIFAC

LIFAC Demonstration

Original Project Schedule



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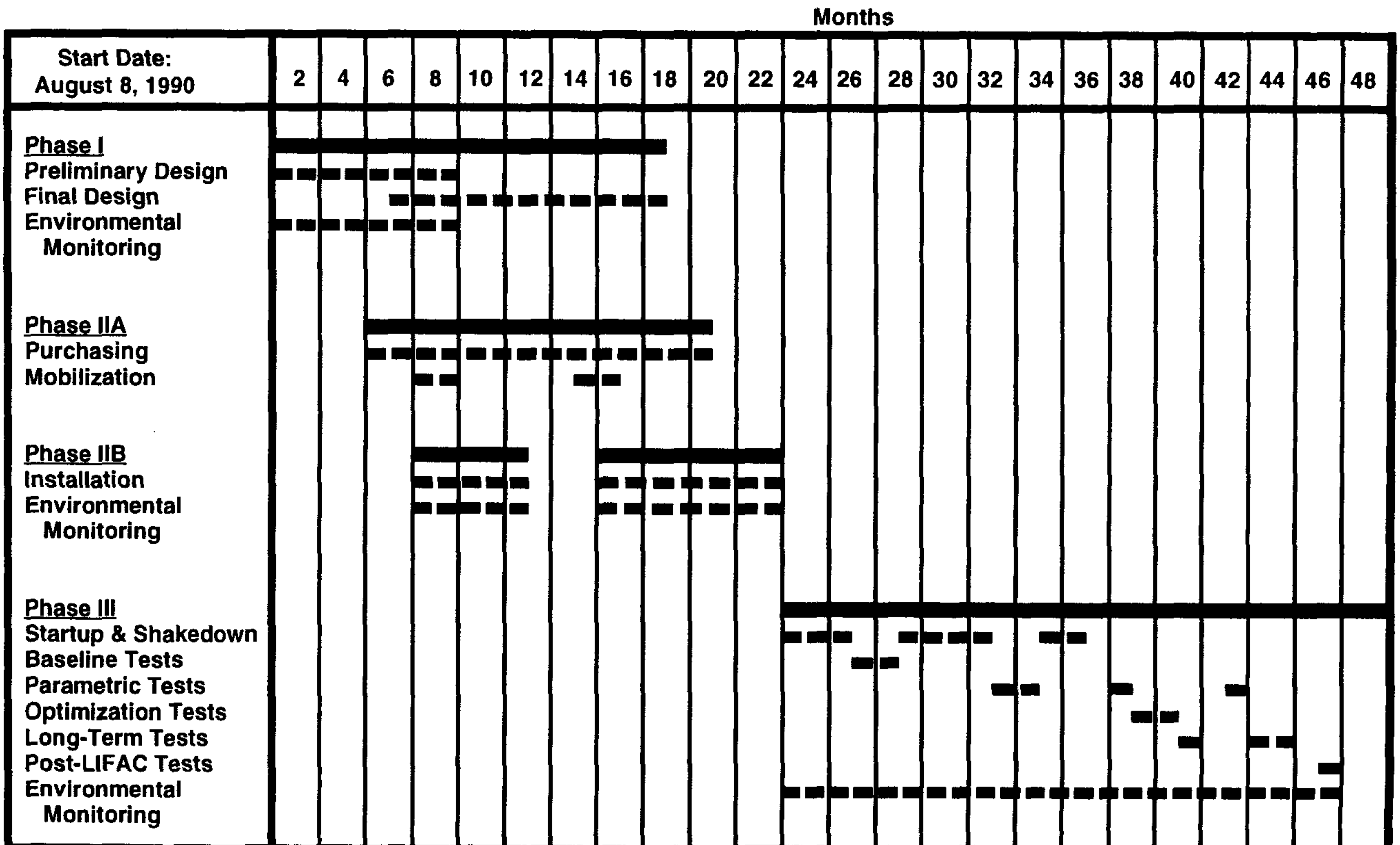
LIFAC Demonstration

Current Project Schedule

(Revised June 1993)



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the total project duration will remain at 48 months.

TECHNICAL PROGRESS

During this report period (January-March 1994), long-term testing was initiated. The variable frequency drive was placed back in service, but failed again after only a few days of operation.

Project Management (WBS 1.3.1)

During January through March 1994, management efforts and achievements included:

- **LIFAC Management Committee Meeting** - During the quarter, the Committee held one (1) formal meeting to discuss project status.

  - On February 2, the Committee met in ICF Kaiser's Pittsburgh office to discuss the status of the VFD, the results of the parametric tests, budget and schedule status, and plans for conducting the long-term tests.

- **Joint LIFAC NA - DOE Cooperation** - During this period, LIFAC NA continued to implement the Cooperative Agreement's management and administrative and technical provisions including DOE reporting and administrative requirements.

  - LIFAC NA sent invoices to DOE during the period consistent with DOE requirements that the project report invoiced and committed costs on a phase-and-task basis.

  - LIFAC NA management reviewed progress on the numerous periodic reports such as the Cost Management Report, the Financial Assistance Management Summary Report, Monthly Progress Report, Quarterly Reports, Milestone Status Reports, etc.

- **Technology Transfer** - During this reporting period, LIFAC NA continued its technology transfer efforts including:

- Technical presentation at the American Chemical Society's Annual Meeting

- Technical presentation at the 19th International Technical Conference on Coal Utilization & Fuel Systems.

Testing and Data Analysis (WBS 1.3.2)

I.D. Fan Motor Loading Test - The Unit No. 2 induced draft (ID) fan motor operates at maximum amperage during peak (65 MW) boiler load. LIFAC increases system pressure drop approximately 4.5 inches of water, causing additional loading on the fan motor. A variable frequency drive (VFD) was installed as a major component of the LIFAC system. The VFD interfaces with the ID fan motor by varying motor current as the pressure drop and flue gas volume change, making the fan more efficient and decreasing the stress on the motor. The VFD has failed several times causing boiler Unit No. 2 to trip. Since the VFD has become unreliable, the LIFAC team decided to perform a test on the ID fan motor with the bypass damper fully closed and the VFD disengaged.

With Unit No. 2 at peak load and 100% flue gas flow through the reactor, the ID fan motor amperage was observed. ID fan motor current reached 160 amps during the test, which is about 10 amps above the continuous load maximum limit. However, the motor has a certain service factor and can be operated at this current if the ambient temperature at the motor is less than 140°F. It was decided that long-term testing can be completed with the existing motor and full gas flow through the reactor; however, the boiler load will be limited to 60MW rather than its peak of 65MW.

Test Procedures - The objective of long-term testing is to evaluate the performance and operability of the LIFAC process over a long, continuous operation period. Testing was originally scheduled to begin in January but was postponed due to inclement weather, resulting in high power demands, and an inoperational VFD. There were a total of two test periods during this quarter. A long-term test was performed in March and an ID fan motor loading test was run on March 30, 1994. Since the VFD failed again on March 3, 1994, a small amount of flue gas was bypassed to decrease pressure drop through the system. Rumpke of Indiana has resumed service as the primary waste disposal company for LIFAC. Lower rates and improved services were negotiated with Rumpke during downtime this quarter. Their proximity to the site enables them to more efficiently remove reactor bottom ash as needed.

Long-term Testing

- Data from parametric and optimization testing was analyzed during this quarter. The results of the analyses enabled the LIFAC team to determine the optimum parameters to be used during long-term testing. In order to perform a controlled study, a fine limestone (80% passing 325M, 93% $CaCO_3$) and constant quality coal (2.25% Sulfur) were employed. The following process parameters were maintained during long-term testing:

Ca/S	= 2.0	(Calcium/Sulfur Molar Ratio)
Rec	= 1.0 psig	(Recycle Prsessure)
T_{rea}	= 135 °F	(Reactor Bottom Temperature)
Bypass	= 13% open	(Bypass Damper)
P_{atom}	= 55-60 psig	(Atomizing Air Pressure)
T_{esp}	= 200 °F	(ESP Inlet Temperature)

- The Ca/S molar ratio set point was maintained at 2.0 during long-term testing in March. The actual Ca/S molar ratio varies according to boiler load and may be inaccurate if the sulfur content of the combustion coal changes during operation. The actual ratio can later be calculated from the lab analyses of the coal.

- Total SO_2 capture improves as reactor bottom temperature approaches saturation temperature. During long-term testing the reactor bottom temperature was maintained approximately 9°F above saturation. At this time, the process is constrained to higher activation temperatures due to the possibility of plugging the steam reheat system. This restraint should eventually be addressed in order to improve reactor efficiency.

- Unit #2 boiler load fluctuated according to power demand. Limestone and water flows automatically adjust to boiler load changes.

- Both the steam and hot gas reheaters were utilized in order to maintain a suitable ESP inlet temperature.

- Coal samples were taken every hour during testing. Fly ash samples from Unit No. 2's ESP inlet hoppers and the activation reactor bottom were grabbed twice per day. A limestone sample was also collected with the ash samples.

- Prior to the I.D. fan motor loading test, the flue gas bypass damper was 13% open.

- Coal quality was consistent during testing this quarter. The sulfur content of the coal ranged from 2.1 to 2.5%.

- Fine limestone (80% passing 325 Mesh) was injected in March. This limestone proved to be more effective than coarse limestone.

- Opacity excursions were experienced during startup of the process and returned to normal after transient conditions had passed.

Testing Results

- Lab analyses show that the sulfur content of the combustion coal varied slightly during long-term testing this quarter. The sulfur content ranged from 2.1 to 2.5%. This fluctuation effects the actual Ca/S molar ratio, and real-time SO_2 reduction trends, since an estimated 2.25% sulfur was entered into the process monitoring system. Results are corrected to actual coal sulfur content upon receiving analyses from the laboratory.

- The average sulfur dioxide capture during the long-term test period was approximately 70% with the Ca/S molar ratio set point at 2.0. Additional capture could have been attained with a lower reactor bottom temperature. However, moist fly ash will slowly foul the steam reheat system (increasing system pressure drop and ID fan amperage) if the reactor bottom temperature remains too close to the flue gas saturation temperature.

- Baseline SO_2 content in the flue gas is approximately 1600 to 1700 ppm. The treated flue gas exiting the process contains nearly 500 ppm. All sulfur dioxide measurements were corrected to a 6% O_2 level for consistency. Total SO_2 reduction and content after the reactor are measured prior to the new gas reheat system. Only 3 to 4% of partially treated flue gas bypasses the reactor through this reheat system.

- Boiler load is calculated from the unit's steam flow rate to the turbine/generator. The boiler load shifted between 48 and 62 MW, depending on the load demand, but maintained 60MW during most of the long-term test period.

- Combustion coal flow is measured two different ways by the LIFAC process monitoring system. The computers constantly record the number of 300 lb. buckets unloaded into each of the three coal mills for the Unit No. 2 boiler. Coal flow is also calculated from the boiler's steam flow. These values are compared and corrected if the coal quality varies or if coal buckets are bypassed.

Modifications and Improvements

- Once again, the variable frequency drive (VFD) failed during this quarter. Prior to the failure, the Ross Hill Control

Company (RHCC) installed a new universal power supply (UPS) and an output amp meter. The unit was then energized and operated in a test mode which isolated it from the ID fan motor. RHCC determined that the VFD was functioning properly. Richmond Power and Light took Unit No.2 off-line in order to facilitate the startup of the VFD on February 27, 1994. Subsequently, the VFD tripped on March 3, 1994 due to capacitor overload. The LIFAC team was forced to find a solution for continuing the test program without the VFD in service.

- One SO_2 analyzer was removed for repairs. Working SO_2 analyzers were in place before and after the LIFAC activation reactor during the test.

- Surface mount resistors were replaced on the Toshiba unit which controls the ESP recycle rotary feeder under hopper No.7.

- Steam and condensate leaks were sealed on the steam reheat system. Also, ash buildup was removed from the steam reheat coils prior to operation and testing. These coils should eventually be replaced by a new gas reheat system.

- The process monitoring system I/O panels had minor hardware problems which did not effect the process.

- Filters were replaced in the limestone feeding silo baghouse.

Environmental Monitoring (WBS 1.3.3)

On December 7 and 8, 1993 the second round of environmental monitoring tests (optimization tests) were conducted (rescheduled from November). Testing was also to be conducted on December 9, but was cancelled due to a problem with an ESP recycle rotary feeder. Monitoring included emissions with a stack test being conducted for each day. Since both Unit No.1 and Unit No.2 were in operation, the emissions testing was conducted at the test portals located on the duct breeching located downstream of the I.D. fan. Ash samples were collected from the economizer hoppers, LIFAC bottom hoppers, ESP inlet and outlet hoppers and the boiler bottom ash disposal bin. The sampling team also monitored the boiler bottom ash discharge water, as well as the plant feedwater which was from the treatment plant discharge on December 7, 1993 and from the river on December 8, 1993. The December 7 and 8, 1993 environmental monitoring results are summarized in Table 1 below.

TABLE 1

ENVIRONMENTAL MONITORING

December 7 and 8, 1993

GASEOUS EMISSIONS

SAMPLE LOCATION	PARAMETERS	LIMITS	ENVIRON. MONITORING 12/7/93	ENVIRON. MONITORING 12/8/93
Downstream of the I.D. Fan	SO_2 (lb/Mbtu)	6.0	3.93	3.75
	TSP (lb/Mbtu)	0.22-0.40	0.253 *	0.206 *
	OPACITY	40%	19-21%	14-18%
	NO_X lb/Mbtu (ppmv)	0-1 (0-588)	337.2	350.3
	PM_{10} (lb/Mbtu)	0-1	0.5527 greater 0.4473 less	0.5066 greater 0.4934 less
	CO_2 lb/Mbtu (%)	0-500 (0 - 50)	13.35	13.83
	CO (ppmv)	0-500	4.13	6.53

* Adjusted average accounting for sootblowing

TABLE 1 (Cont'd)

ENVIRONMENTAL MONITORING

December 7 and 8, 1993

AQUEOUS EFFLUENT

SAMPLE LOCATION	PARAMETERS	LIMITS	BOTTOM ASH (AQUEOUS) 12-7-93	BOTTOM ASH (AQUEOUS) 12-8-93
BOILER	FLOW	REPORT	-	-
BOTTOM	TSS (mg/l)	70	30	38
ASH	OIL & GREASE (mg/l)	15	<1.0	<1.0
DISPOSAL	TOT. RESID. OXIDANTS (mg/l)	0.02	<1.0	<1.0
BIN	TEMPERATURE (°F)	REPORT	-	-
	AMMONIA (NH_3) (mg/l)	1.8 (SUMMER) 2.6 (WINTER)	0.10	0.37
	COPPER (mg/l)	0.05	<.010	0.012
	LEAD (mg/l)	0.02	<0.10	<0.10
	ZINC (mg/l)	0.46	0.011	0.020
	ALUMINUM (mg/l)	0.40	0.46	0.53
	IRON (mg/l)	REPORT	0.16	0.11
	PCBS (mg/l)	REPORT	<1.0	<1.0
	ALKALINITY (mg $CaCO_3$)	-	31.1	40

TABLE 1 (Cont'd)

ENVIRONMENTAL MONITORING

DECEMBER 7 AND 8, 1993

SOLID WASTE AND BY PRODUCT:

	SAMPLE LOCATION									
PARAMETER	ECON. ASH 12-7-93	ECON. ASH 12-8-93	LIFAC ASH 12-7-93	LIFAC ASH 12-8-93	FRONT ESP HOPPER 12-7-93	FRONT ESP HOPPER 12-8-93	BACK ESP HOPPER 12-7-93	BACK ESP HOPPER 12-8-93	BOTTOM ASH 12-7-93	BOTTOM ASH 12-8-93
TCLP METALS (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TCLP VOLATILES ORGANICS (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TCLP BASE/NEUTRAL EXTRACTABLES (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TCLP ACID EXTRACTABLES (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
SULFATES (mg/l)	1600	1700	1500	990	1700	1600	1600	1600	110	920
ALKALINITY (mg $CaCO_3$)	2090	2130	1050	1850	2250	2400	2560	2400	87	168
VOLATILE ORGANICS ug/kg (VOC)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL EXCEPT METHYLENE CHLORIDE 13.0 ug/kg	BDL
pH	12.55	12.52	12.42	12.41	12.42	12.60	12.52	12.52	11.21	11.86

(BDL - BELOW DETECTABLE LIMITS)

The sample team also monitored the plant's feedwater for the two days of testing (December 7 and 8,) since its incoming quality is believed to be impacting compliance with effluent criteria in accordance with RP&L's NPDES Discharge Permit. Feedwater for the plant is either pumped from the river, or during dry seasons, is pumped from the local sanitary treatment plant's effluent discharge. During the December tests, the feedwater was coming from the sanitary treatment plant's effluent discharge on December 7, 1993 and from the river on December 8, 1993. The results for the feedwater monitoring for December 7 and 8, 1993 are summarized in Table 2.

TABLE 2

FEEDWATER MONITORING

DECEMBER 7, AND 8, 1993

Sample Location	Parameters	Limits	RP&L Monitoring (1993) July	Aug.	Sept.	Oct.	Nov.	Dec.	Feedwater Sample Location (Z) 12-7-93	12-8-93
Feedwater Influent Pipe	Flow	Report	-	-	-	-	-	-	-	-
	TSS (mg/l)	70	17.9	20.4	19.1	13.1	19.5	15.4	<1	9
	Oil & Grease (mg/l)	15	<1.0	<1.0	<1.1	<2.72	<1.82	<1.34	<1.0	<1.0
	Tot. Resid. Oxidants (mg/l)	0.02	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<1.0	<1.0
	Temperature (F)	Report	88.2	85.2	77.1	64.7	61.2	61.3	-	-
	Ammonia (NH3) (mg/l)	1.8 (SUM) 2.6 (WIN)	0.16	0.09	0.110	0.18	0.03	0.062	<0.10	<0.10
	Copper (mg/l)	0.05	0.033	0.038	0.057	0.046	0.064	0.020	<0.010	<0.010
	Lead (mg/l)	0.02	0.007	0.007	0.006	0.006	0.004	0.002	<0.10	<0.10
	Zinc (mg/l)	0.46	0.053	0.046	0.054	0.071	0.098	0.040	0.024	0.019
	Aluminum (mg/l)	0.40	1.094	1.045	1.066	0.824	0.528	0.880	0.36	0.82
	Iron (mg/l)	Report	1.281	0.612	0.936	1.040	1.747	1.280	0.057	0.73
	pH (pH units)	6.0 Min/ 9.0 Max	7.5	7.5	7.7	7.4	7.7	7.8	-	-
	PCBs (mg/l)	(EMP)	-	-	-	-	-	-	<1.0	<1.0
	Alkalinity (mg CaCO3)	(EMP)	-						262	248

FUTURE PLANS

- Conduct the next round of environmental monitoring tests in May.
- Submit the compliance report to IDEM for the May stack tests.
- Complete long-term testing.
- Submit final report - Volume 1 : Public Design.
- Submit Baseline Testing and Parametric Testing Reports.
- Continue mechanical and electrical repairs to the LIFAC system to maintain a controlled testing atmosphere.
- Continue normal administrative and financial reporting to DOE.